

Abstract of

Broadening Horizons in Farm Electrification

by

Arthur W. Turner, Assistant Chief in Charge of Agricultural Engineering Research, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, before the West Virginia Farm Electrification Conference, Jackson's Mill, West Virginia, April 10-12, 1951.

The extension of electric lines to farms has hastened the progress of agriculture in the United States. It is imperative that electrification research keep pace with this expanding service, so that farmers can make the greatest possible use of this source of energy.

Successful research depends on both public service agencies and industry. It is often the function of public services to supply the basic research, which industry, in turn applies to fit farm conditions. Basic farm electrification research, now in its 28th year, has been conducted cooperatively by the U. S. Department of Agriculture, the State Agricultural Experiment Stations, and industry. The government's research is centered in the Division of Farm Electrification, an agricultural research agency, U. S. Department of Agriculture with headquarters at the Agricultural Research Center. The research programs are conducted at several of the State Agricultural Experiment Stations.

Much of the early farm electrification research was aimed to take the hard labor out of farming. The achievement of this aim is shown in the wide number of farm chore jobs now accomplished with electric power.

A broader, future aim of farm electrification research is the application of this energy as light, heat, power and radiation to allow the farmer to produce food and fiber more quickly and with less work; to condition this food and fiber so that its finest quality will be maintained, and to store and transport these commodities to gain the most advantageous marketing.

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It is a real pleasure for me to discuss the subject of farm electrification research before this conference. I know of nothing that has so sparked our progress in industry and agriculture in recent years as the extension of electric lines. I know of nothing that offers greater promise than research to apply the energy from these lines in production, labor saving, processing, marketing, and better living.

Electric lines now blanket this country from coast to coast like a giant web. The arteries of this distribution system stretch out from the central power stations, striking as the crow flies over mountains and valleys and across the plains. The high steel towers that carry these lines across the West Virginia landscape to disappear into the distance appear lifeless, but the pulsating hum of the wires is the symphony of power and strength in our modern America. The "juice" they carry is a super-duper sort of stuff that causes our cities and towns to bustle with activity by day and glow with incandescent, neon, or fluorescent lights by night.

Nowadays no one needs to be told the meaning of the word "juice" as applied to electricity. Once a part of the jargon of the electrical business, it has become so commonplace in our language that it is understood by school boys in the remotest hills and valleys. It has always seemed to me to be a particularly fortunate term for electric energy. Electricity is as fluid as water. You pump it in at one end of a line and put enough force behind it and you can draw it off at the end of the line miles away or at any place in between where a tap is made.

In recent years the web of our electric system has been filled in until it is difficult to find a farm that can not tap this source of power. It is an interwoven system so that power is seldom off in any area. The lacework of this web is an intricate one, but it is designed to give dependable service even to the last man at the end of the line, who in most cases is a farmer. It is the development of applications and improved uses of electric energy in production operations as well as in better living for this fellow at the end of the line that our farm electrification research in the U. S. Department of Agriculture is concerned.

Some Intriguing Research Possibilities

Each time I talk with engineers working in the farm electrification field I become more intrigued with the possibilities for use of electricity in farming. Engineers under direction of Dr. Truman Hienton in our Division of Farm Electrification, for example, are working with electric lamp traps that attract and electrocute many destructive crop insects. They are making some

progress in developing an automatic egg candler that will not only pick out the good eggs from the bad but will select the very good from the near good. They are exploring possibilities of ultrasonic treatment of plant seeds for improving viability or stimulating plant growth. Other current farm electrification research by Department engineers in cooperation with a number of States has as objectives improving efficiency in pig production, increasing poultry and egg production, saving the feed nutrients and cash values of many farm crops through removal of excess moisture, and expanded use of refrigeration on the farm for improving quality and marketing of perishable products.

Theodore Johnson, president of the J. I. Case Company and also of the Farm Equipment Institute, made a statement last fall that I'd like to pass along to you. He said: "We should continue to develop new machines and improve those we have. We have not, in spite of all the progress that has been made in the past, in spite of all the engineering effort that has been put forth by the industry through the years and is being put forth at the present time, reached the point where we can say that there is nothing further ahead for us."

Personally, I hope the industry never reaches that stage. Chas. F. Kettering said, "Research is learning what to do when we can no longer continue what we are doing now." Another industrialist, in a paper on the Why's, Where's, and Who's of Research, said that "without research, industry dies." He divided research between the fields of "pure" and "applied" research. It should be the job of the university or Government scientist to do the basic research, he said; applied research should be done largely by industry after it has left the pilot-plant stage. Accepting that division of responsibilities, I should like to discuss the organization and place of public service research and then touch briefly on the types of work under way in the U. S. Department of Agriculture.

Electrification research of the Department of Agriculture is centered in the Agricultural Research Administration and delegated specifically to the Farm Electrification Division of the Bureau of Plant Industry, Soils, and Agricultural Engineering. It is one of the four Agricultural Engineering Divisions with headquarters at Beltsville, Md., devoted to the development of engineering applications for the farm. All of this research is carried on cooperatively with the other research agencies in the Agricultural Research Administration or with State agricultural experiment stations. By request of the American Society of Agricultural Engineers Advisory Committee on Farm Electrification Research Dr. Hinton and his staff also act as a clearing house of information on all public service farm electrification research.

Importance and Place of Public Research

I should like to illustrate the responsibilities of public service research in this field with our work on electric traps for controlling certain crop insect pests.

Many, if not all, night-flying insects are attracted by light. If these insects can be killed in this adult stage before they lay their eggs, the battle to control the larvae or worms will be easier, and even complete control may thus be possible. Our work, cooperative with the Indiana Experiment Station

at Purdue, and the Iowa Experiment Station at Iowa State College, has indicated that the corn borer moth is one insect attracted by light. Obviously, this moth is not attracted to white light or it would fly in the daytime. Then, what color does attract this moth? Research has shown those wave lengths of light some, invisible to the human eye, at the blue end of the spectrum to be most attractive to this as well as a number of other insects.

In continuing this project cooperatively with the entomologists, plant specialists, electrical manufacturers, and power distributors, we hope to determine the most attractive light, the intensities to use, the most desirable light placement, and length of night exposure to attract and kill corn borer moths, corn ear worm or cotton boll worm moths, the tobacco and tomato hornworm moths, and other night-flying insects. These latter phases of study are under way in North Carolina, Georgia, Virginia, and here in West Virginia.

It is hoped that manufacturers can, on the basis of information from this one coordinated project, develop proper sizes and location of lamps and traps, and that power distributors can work out recommendations for frequency and layout of traps for efficient use. The lamps and traps may not look alike, but they should be designed to do the same job based on research findings. Without public service research each potential manufacturer would have to employ scientists in each subject-matter group and conduct the work at several locations. Public research, in turn, needs industrial research to take our research developments and design them to fit the needs and the pocketbook of the farmer. Many other examples could be cited to illustrate basic research and our responsibility.

Engineering--particularly applications of electricity with its many ramifications--has done much for industry, manufacturing of all types, transportation, commerce, and communications. It can and will do as much for agriculture. The small number of public service research workers, with the aid of manufacturers and other segments of industry, have already performed important service in adapting urban and industrial electrical devices to use on the farm.

Research Now 28 Years Old

Research in this field of farm electrification was inaugurated just 28 years ago with the formation of the Committee on the Relation of Electricity to Agriculture. Experiment station workers in 26 States were soon conducting work in the program. Within 10 years they had accumulated a vast amount of practical information and had developed a number of new uses for electricity. By 1933, work was under way on electric chicken brooders, soil heating, poultry, dairy and stock water heaters, and lamb brooders, tank-type milk coolers, arc welders, electric fences, feed grinders, ensilage cutters, and irrigation pumps. Today most of these are "old stuff"--standard equipment on many of our farms.

This work has shown us that in thinking of the possibilities of electricity in agriculture, we must always anticipate the future--the needs and requirements of production, storage, and transportation that will have to be met tomorrow. The successful research engineer must visualize the methods, procedures, commodities, homes and other farm buildings as they may need to be in future years, and plan his work to satisfy these future needs.

In the examples of electrical research just reviewed, workers in each State carried on basic research in adapting findings of the different stations to fit their local conditions. From the beginning, various manufacturers aided the States by furnishing test equipment and, in some cases, personnel. The utility industry also helped provide funds to carry on the Committee's early projects.

Of the four forms of electric energy available--power, light, heat, and radiation--light was perhaps the first application, but electric power may now surpass light in common use. Certainly, however, on the farm, electric power and the substitution of electricity for other forms of power are highly important. On many farms, the electric motor has replaced the gas engine for pumping water and providing water under pressure all around the buildings and possibly for irrigation. The electric motor is replacing the washing machine gas engine, the feed grinder engine, and moving into many farm jobs where it replaces hand labor.

Man's Labor Worth Only 3 Cents

Compared with the present cost of electricity, the labor of a man from his ears down is worth only 3 cents a day. It is obvious that many more electric-motor-operated devices should be in use on farms to take over the work of men and women. At present, research on such electric motor applications is under way on barn cleaners at the State Agricultural Experiment Stations in Michigan, Wisconsin, Iowa, and West Virginia; on silo unloaders in Wisconsin; coolers for poultry houses in New Mexico; poultry house vacuum cleaners in California; supplemental irrigation in South Carolina, Washington, Nebraska, Montana, and California; and forage drying methods in many States.

Of course, there are many more potential uses of electric power on the farm. It is, for example, the chore power. At present it is estimated that from 20 to 80 percent of all farm labor is done around buildings, mostly the repetitive jobs that come every day and sometimes two or three times a day.

This substitution of electric power for human labor is becoming of increasing importance as farm manpower is recruited for service in the armed forces or in defense plants. Several new farm electrical machines have been developed since World War II that will help to replace hand labor. Some of these important machines are the crop drier, the gutter cleaner, the automatic poultry feeder, the portable elevator, and the silo unloader. The Agricultural Engineering Department of the West Virginia Agricultural Experiment Station has made valuable contributions to the gutter cleaner and elevator development.

During the past year our engineers at the Research Center at Beltsville, Md., have been working on an electric hay mow conveyor. This device is being designed to distribute partially cured chopped hay over the ducts or slatted floor of a forced-air curing system with a considerable reduction in labor and places the hay uniformly on the barn drier. Another labor-saving machine under development by the Division in cooperation with the Illinois Agricultural Experiment Station is an electric motoring device to regulate the flow of three different materials into a feed grinder. The materials, such as corn, oats, and mineral-protein supplement, are then mixed by the feed grinder as they are ground, eliminating the labor of hand mixing or the use of a feed mixer.

Investigations on the curing of bright-leaf tobacco have been conducted cooperatively with the North Carolina and Georgia Coastal Plain Agricultural Experiment Stations and Forest Service of USDA for the past several years to improve curing methods and equipment. Two important labor-saving devices have been developed in this work. The first, an automatic wood-burning furnace with electric heat controls reduces the labor required to observe and regulate temperatures in the tobacco curing barn and also the fire hazard. The second device is an electric control for oil and coal-burning curers that not only regulates temperature and humidity but also increases the temperature at a fixed rate during the curing period. Other research in tobacco curing includes work on cigar wrappers, dark-fired and shade-grown varieties.

The preservation of food and feed produced on the farm to the fullest possible extent by economical methods is a major agricultural problem. Refrigeration is important in preserving food and the Division of Farm Electrification is investigating the requirements for farm refrigerators to store foods for the household as well as marketable surpluses. The Bureau of Human Nutrition and Home Economics at Beltsville and the Texas and Washington Agricultural Experiment Stations are cooperating in these investigations.

The feeding value of farm produced forage and grains can be preserved in many cases by the use of farm driers. Investigation at Beltsville by specialists in agricultural engineering, dairying, and forage crops have determined that by drying of forage crops materially reduces losses in feed value as compared with field drying. The drying of grain by dielectric heat is being investigated cooperatively with the Louisiana and Nebraska Agricultural Experiment Stations.

Farmers have many other drying and heating problems. The present emergency emphasizes the need for conditioning both food and feed commodities for indefinite storage. Our engineers have inaugurated a project on basic drying or conditioning relationships for grain, forage, and fibers. Engineers need to know how moisture moves from the center of a seed, leaf or fiber to the outside where it can be evaporated or absorbed as well as the conditions favorable to moisture movement. Possibly continued blowing of atmospheric or heater air on commodities may be the answer. Many of us believe, however, that there may be more effective and controllable procedures. Once such basic information is known, the conditioning limits can be established with the cooperation of the commodity specialists, thus expediting conditioning.

Electric energy can play a very important part both in conditioning a commodity and in keeping the commodity in the proper condition during storage. Incidentally, one of our agricultural engineering objectives is to provide the grower with conditioning and storage facilities on the farm or in nearby communities so he can hold his commodities and market them at his convenience rather than have to dispose of them on a flooded market.

Electric ventilating equipment for animal shelters and poultry houses offers farmers possibilities for much closer control of temperature and humidity than by any other method. Specifications for such electrical equipment will be developed only through studies conducted in various regions of the United States. In those of very high summer temperatures, the effects of

reducing temperatures by air movement alone or in combination with evaporative cooling certainly should have research attention.

Electric energy in the form of heat, including radiant heat, has several applications in the home and in farm buildings, but here again the surface of possibilities has hardly been scratched. Such applications are closely related to light, and include erythema, infrared, and dielectric radiations.

Infrared lamps are being used as the source of heat for saving young pigs by a large number of farmers and to some extent for brooding chicks. However, we need to know more about energy requirements of the newly born pig or chick before exact recommendations are made to farmers on size and type of lamp to use. Infrared lamps have been used experimentally in other ways---for frost protection in orchards, for drying apples that have been dipped in wax, and for drying seed and grain. A commercial drier using these lamps has been developed for grains. In general, however, use of electric heat on the farm has not attained the success it has in industry. At present our information on the relation of infrared lamps to release of moisture by various seed, grains, and plants is limited. Research can help us clear up many of these puzzling problems. Several State experiment stations are studying effects of soil heating cable in chick brooders, and in plant propagation.

Challenging Questions for Engineers

Radio frequency may have many valuable applications in agriculture. The New York Experiment Stations and the U. S. Western Regional Laboratory are investigating its use for blanching. California is exploring its use for the control of bacteria. The use of radio frequency may stimulate plant growth. This would be extremely useful to the nurseryman who supplies the grower with seedlings. It might be used not only in propagating crop plants but also in growing flowers.

One of the new, challenging applications of electricity in agriculture is ultrasonic energy. Some reports in both scientific and popular magazines have indicated startling possibilities, including such things as pasteurizing and homogenizing milk in a single operation, increasing the viability of seeds, electric seed selection, killing or controlling undesirable enzymatic action of vegetative commodities, and others. Actually engineers do not know what ultrasonic energy will do. Some preliminary investigations have, however, been started in our laboratory at the Agricultural Research Center, Beltsville, Md.

Intensified use of new and more devastating chemical insecticides is taking its toll of pollinating insects as well as pests. Beekeeping for pollination of fruits is a growing enterprise, with honey as an extra cash crop. Strong colonies early in the spring are essential for effective pollination and one method of obtaining them in the northern States may be controlled electric beehive heating to prevent heavy winter losses of bees. Development of electric means of heating beehives is therefore another project that our engineers have initiated recently.

For years we have been using electrical energy in the form of light for our egg candling, but unfortunately we are not using the energy to our best advantage. We need to know just what type of light is best suited to show the interior quality of the egg, and work is being done on this problem now. Of course, the ultimate goal is to develop a completely automatic unit for candling eggs, but before we can do this we must know more about the light transmitting characteristics of the egg shell, albumen, and yolk. Maybe instead of light some other type of radiation, such as X-ray, radio frequency, or ultrasonics, will prove more effective. These possibilities and others are all being investigated to find the best means for determining the interior quality of the egg.

The heat pump or reverse-cycle refrigeration unit may have many opportunities for use on the farm. It either pumps heat from the ground to a building or reverses and pumps the heat into the ground and may make it possible to maintain a constant temperature the year round in storage structures or animal shelters. The same principle appears to have decided advantages in transportation by train, truck or boat, of many perishable commodities. Our research engineers would like to have the facilities and resources to investigate these and many other possibilities.

Many processes in agriculture that have been long considered arts are today becoming exact sciences as a result of research findings. Curing tobacco, grading tobacco, grading fruits and vegetables, and candling eggs are all examples. Electric energy is fast taking over and changing these so-called arts to science. Electric controls permit precision operations. They will continue to establish new standards for agricultural practice.

The electric revolution occurring on farms as service lines are expanded will take on greater magnitude with each new step forward. If full advantage is to be taken of this energy on farms, utilization developments must not be allowed to lag further behind. The combined and continued interest of this and similar organizations will help implement expansions in public service farm electrification research programs. Engineers in public service research are your servants and will move ahead as rapidly as facilities permit.

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